

HSR AERODYNAMIC PERFORMANCE STATUS AND CHALLENGES

5/1/02

HSR Aerodynamic Performance Technology Management Team

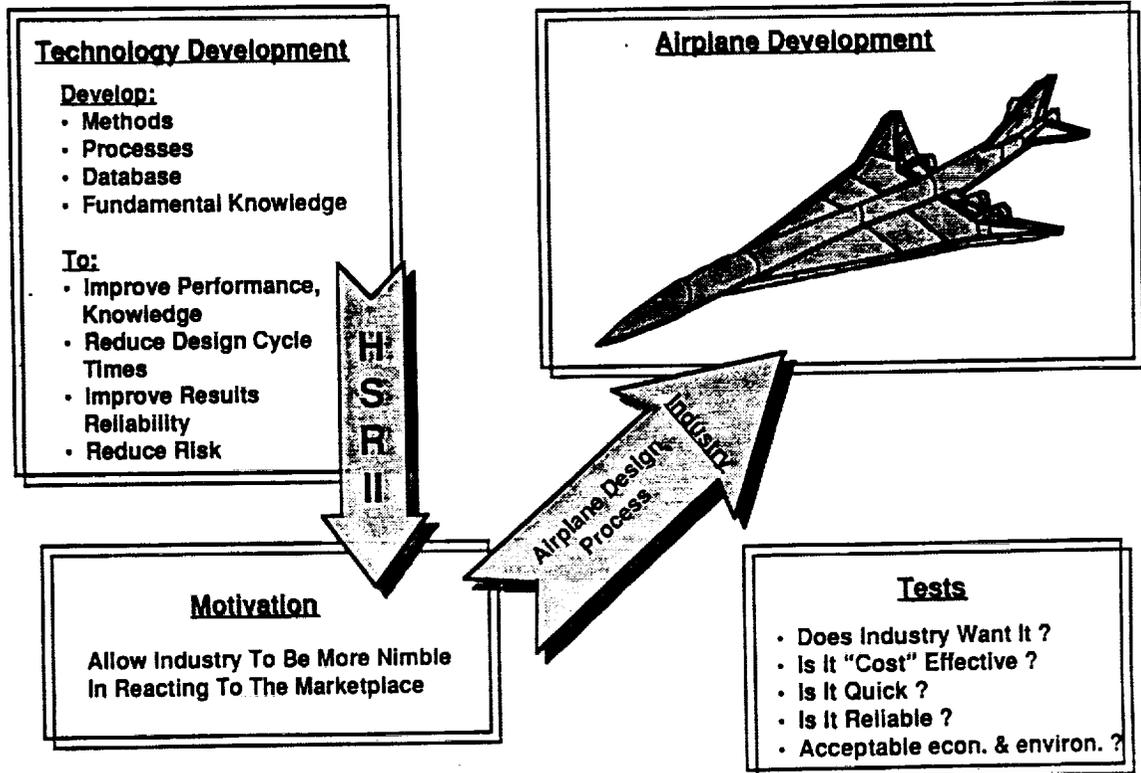
**Bill Gilbert, NASA LaRC
Tony Antani, McDonnell Douglas
Doug Ball, Boeing
Rob Calloway, NASA LaRC
Phil Snyder, NASA ARC**

**Presentation at First Configuration Aerodynamics Workshop
NASA Langley Research Center, Virginia
February 27, 1996**

Presentation Outline

- Introduction
- Aero impact on HSR
- Goals and Targets
- Progress and Status
- Remaining Challenges
- Summary

HSR Technology Development Charter



ROAD AHEAD IS STEEPER & SLIPPERY!

- **Aeroperformance has delivered on promises to date**
- **Future gains will be more difficult and will require excellent teamwork within Aero and in HSR**
- **Materials/Structures & Propulsion have encountered major problems in achieving needed gains**
 - Aero is being asked to provide more help in meeting the takeoff noise goals
- **As a result, pressure on aero to do even better will increase!**
 - We'll be squeezed to get every last drop of performance possible!
 - But we must maintain our confidence level in the performance gains we predict

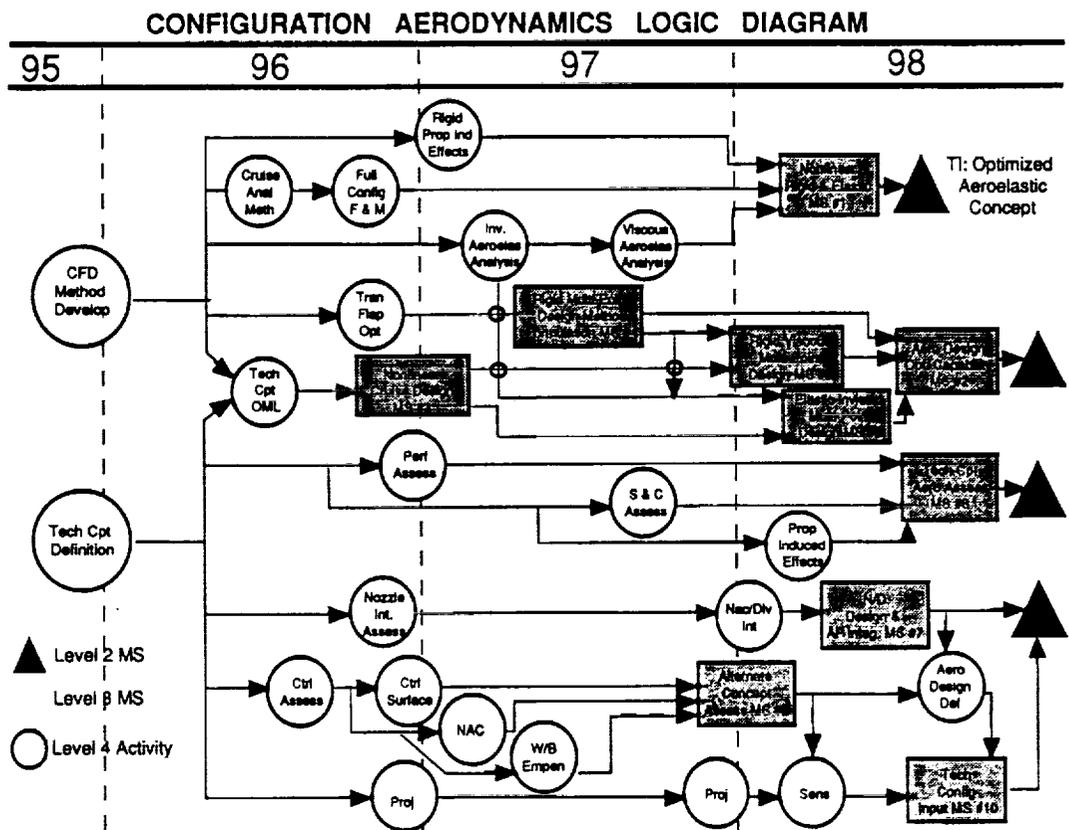
Aerodynamic Performance Objectives & Impact

Develop and validate design & analysis methods & database to:

- **Maximize low speed and cruise performance with acceptable S&C; help reduce community noise**
 - **Impacts on TOGW:**
 - **1-count drag reduction: 7K lbs @M2.4; 1K lbs @ M0.9**
 - **10% increase in highlift L/D gives about - 1.5 dB at C/B.**
 - **SLFC potential large gain(8%!), if feasible**
- **Provide good F/Q in a certifiable, safe airplane with low noise ops capability - essential to ensure viable, flyable product**
- **Soften sonic boom - goal feasible, not validated yet**

GOALS AND TARGETS

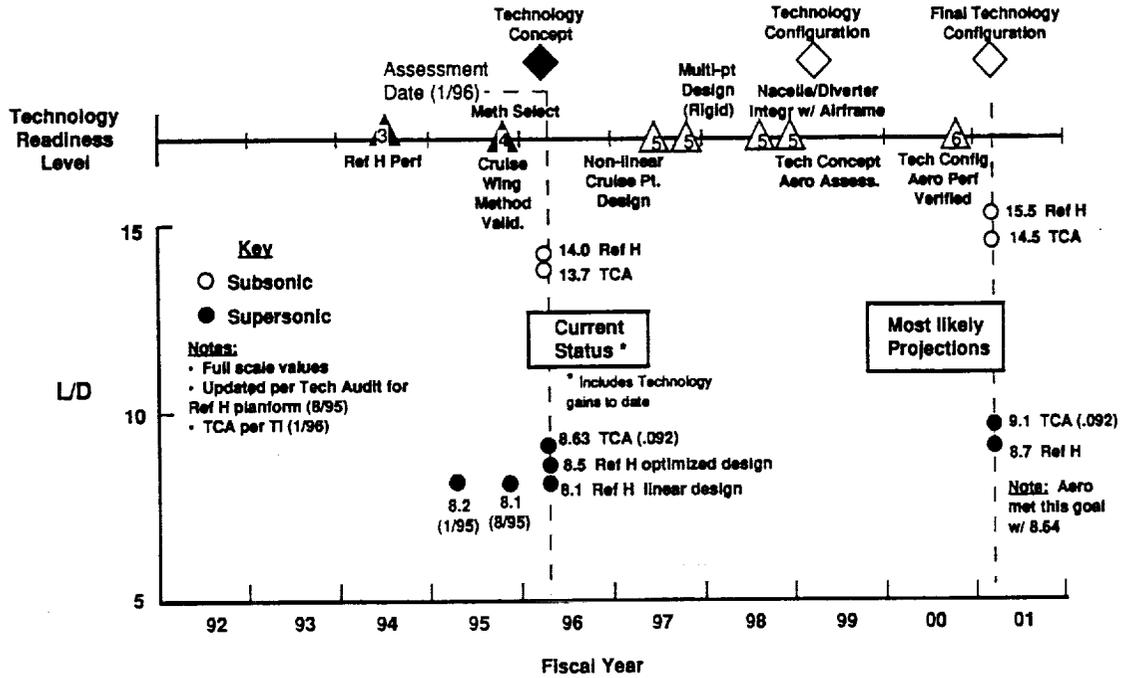
DON'T LOSE SIGHT OF THEM



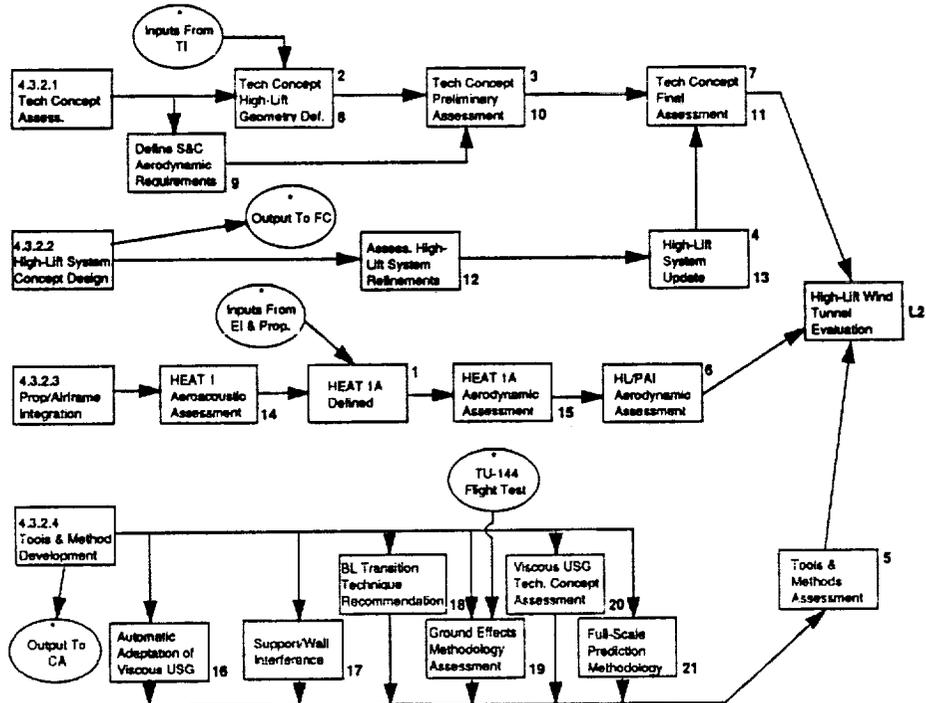


Aerodynamic Performance Configuration Aerodynamics

Technical Performance & Technology Readiness Level



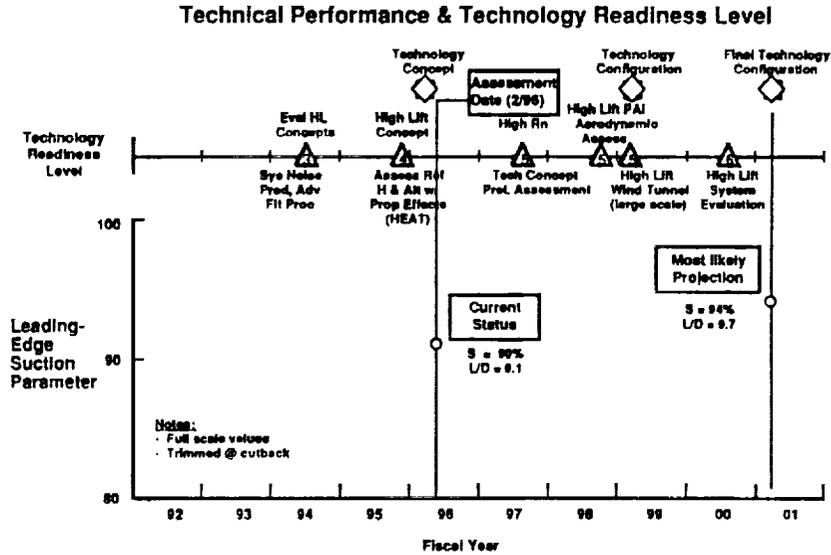
4.3.2 High Lift Technology Logic Flow Diagram



Note: Number at upper corner is Level 3 milestone number.
 Number at lower corner is Level 4 milestone number.
 * Interfaces with other program elements described in sections 3.14-15.



High Lift Technology Metrics



Progress and Status

Configuration Aerodynamics - Developed database to satisfy Level 2 milestone “Ref H Assessment”; validated nonlinear aero optimization methods and a large aerodynamic performance gain via optimization.

High Lift - Downselected to preferred high-lift system concept; satisfied Level 2 milestone for HEAT 1 aeroacoustic tests.

Sonic Boom - Achieved boom softening goals and acquired exceptional flight data for boom propagation methods validation.

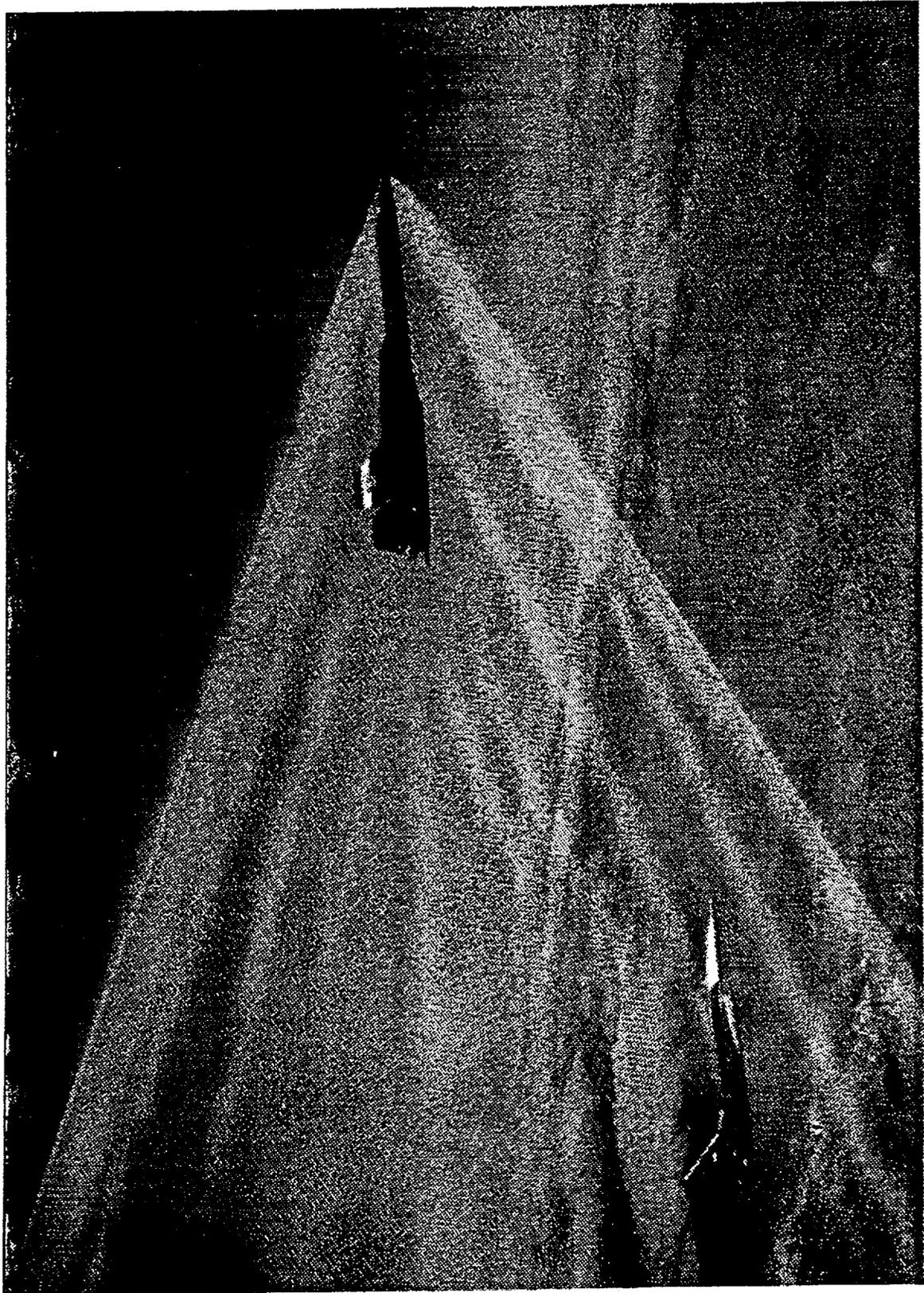
SLFC - Transition prediction methods transferred to industry; SLFC flight experiment developed and underway.

Flight Control - Developed excellent full-envelope simulation and conducted piloted assessment of Baseline configuration

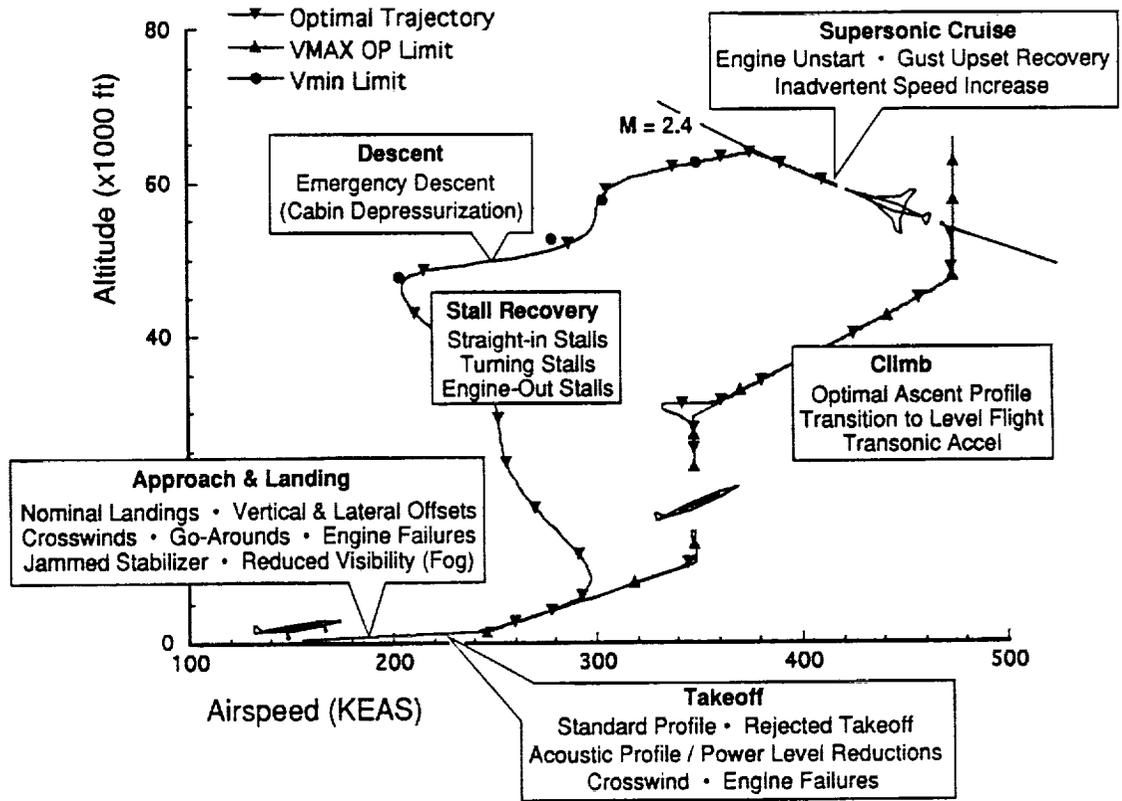
BOEING W27 CONFIGURATION: AIRPLANE $M = 2.4$ $CL = 0.12$







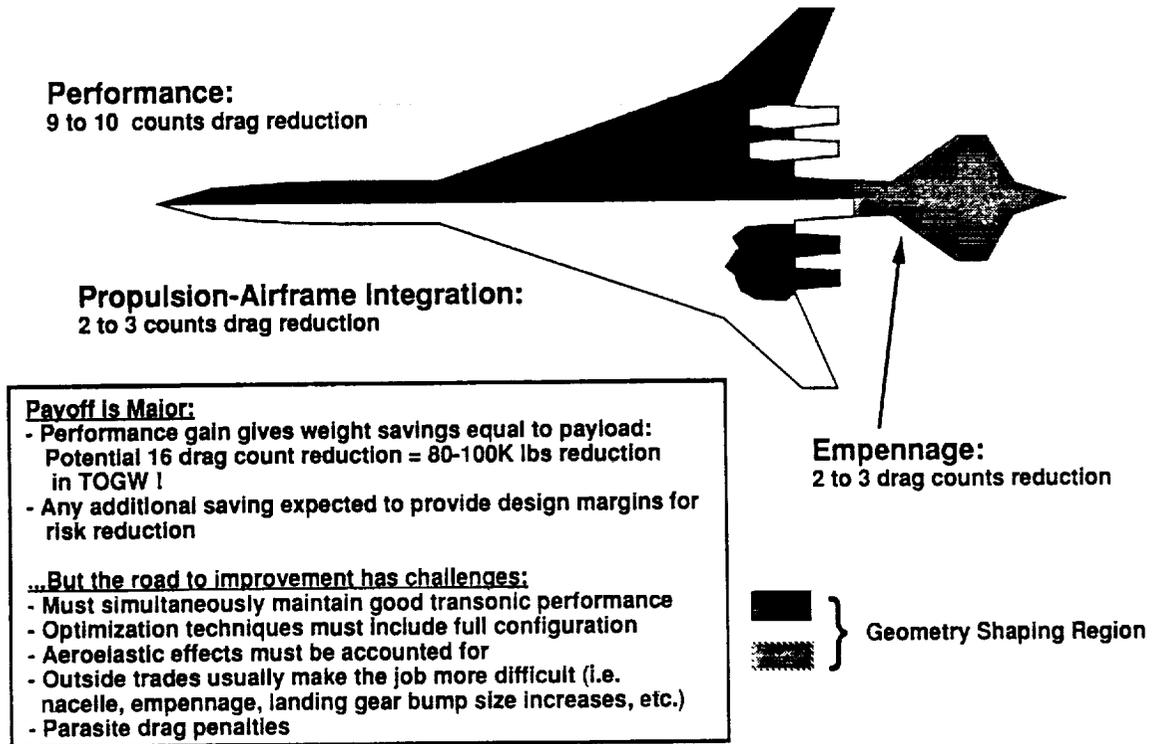
Ref. H Flight Regimes and Maneuver Tasks Examined



REMAINING CHALLENGES

- **Increase Performance gains**
 - within resources available
 - realizable in integrated vehicle
- **Reduce Uncertainties**
 - expected full-scale performance
 - confidence in design methods/concepts

**CONFIGURATION AERODYNAMICS DESIGN:
GEOMETRY SHAPING ALLOCATIONS BY DISCIPLINE**
Drag reductions projected for aero design at Mach 2.4



CONFIGURATION AERO CHALLENGES

- Find the right complementary roles for NASA and industry to get best affordable technology into methods and airplane concepts while ensuring good, robust integration of these methods and concepts into the industry HSCT design capability.
- Begin to focus on best methods(narrow the field) to allow maturing them and improving their robustness, speed, and utility.
- Attach “belly buttons” to each key deliverable and hold them accountable for development and reporting -- within available resources -- don’t micromanage.

HIGH LIFT CHALLENGES

- **Increased Performance**
 - **Leading edge suction increase to 94% (that's a bunch!)**
 - **Accomplish gain with smaller/lighter system on TCA**
- **Reduced Uncertainty**
 - **Full scale Rn**
 - **Realistic system and aircraft geometry**
 - **Propulsion effects**

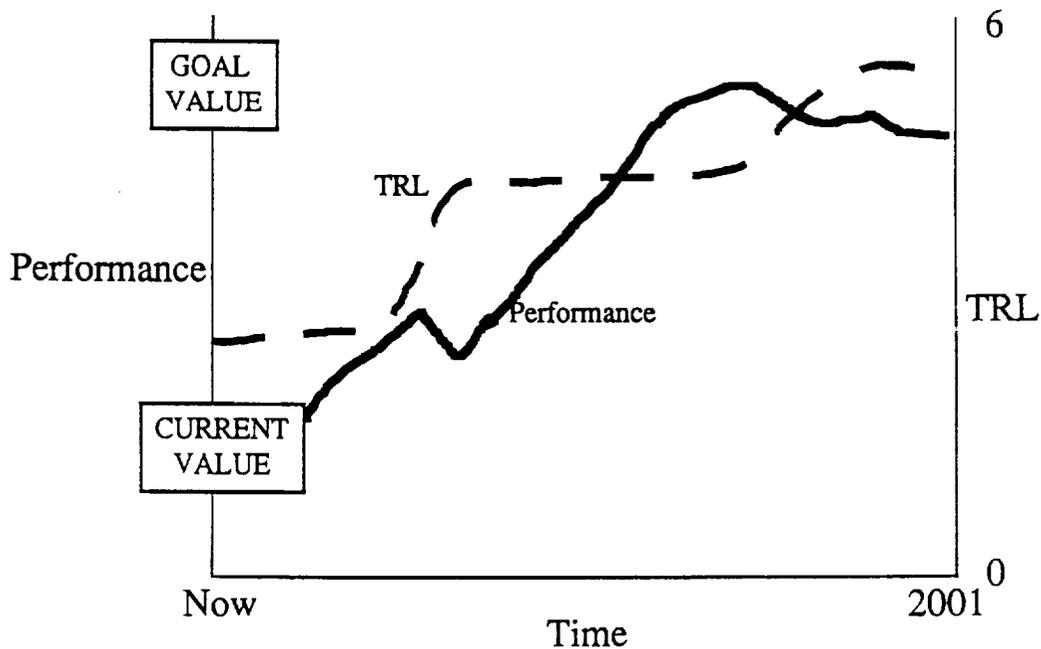
FLIGHT CONTROL CHALLENGES

- **Develop flight control laws to handle large spectrum of flight dynamics and the propulsion/flight control integration in HSCT.**
- **Help define right balance of inherent stability vs. control power for an HSCT.**
- **Continue providing high-fidelity look at the flight performance of the integrated technology baseline for HSR.**

OTHER KEY CHALLENGES

- Limited resources -- tighter for Aero now
- Limited supercomputing time --
 - NAS oversubscribed (essential to use other supercomputing platforms where possible)
 - Essential for HSR AERO goals
- Wind tunnel facilities
 - availability and schedules
 - most effective use (quantity & quality)

IMPORTANCE OF TECHNOLOGY READINESS AND PERFORMANCE



SUMMARY

- **Great progress to date. Thanks from the TMT.**
- **While we are developing the technology, we must learn to operate as the HSR Team versus the Ames, Langley, Douglas, or Boeing Team.**
- **Each ITD team should play to the strengths of team members as you execute your plans.**
- **We must plan our work to be achievable within the time and resources available -- and then manage the effort accordingly -- watch products versus expenditures.**
- **We must understand and address the real vehicle integration and operational constraints -- need good real-time interaction with TI and other ITD's.**
- **When we finish the HSR Program, U.S. industry should have the best HSCT design capability in the world....not NASA, but industry.**